



DOCKET NO. 1567.1022

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

Soo seok CHOI, et al.

Serial No. 10/072,907

Group Art Unit: 1745

Confirmation No. 3556

Filed: February 12, 2002

Examiner: Raymond Alejandro

For: LITHIUM-SULFUR BATTERIES

APPEAL BRIEF UNDER 37 C.F.R. § 41.37

Mail Stop Appeal Brief-Patents
Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Sir:

Pursuant to the Appellant's earlier filed Notice of Appeal on June 5, 2006, Appellant hereby appeals to the Board of Patent Appeals and Interferences from the final rejection mailed February 6, 2006. By virtue of a Petition of a One-Month Extension of Time filed herewith, the extended period for response set to expire on September 5, 2006. Appellant submits this Appeal Brief along with the filing fee of \$500.00 set forth in 37 C.F.R. §41.20(b)(2).

Also enclosed is a Claims Appendix in compliance with 37 C.F.R. § 41.37(c)(1)(viii). An Evidence Appendix in compliance with 37 C.F.R. § 41.37(c)(1)(ix) is enclosed and indicated as being NONE. A Related Proceedings Appendix in compliance with 37 C.F.R. § 41.37(c)(1)(x) is enclosed and indicated as being NONE.

I. Real Party in Interest

Due to the assignment executed on February 6, 2002 by the inventors Soo Seok CHOI, Yunsuk CHOI, Yonju JUNG, Jaewoan LEE, Duck Chul Hwang, Joo Soak KIM, Zin PARK, Seok

KIM and Ji Sung HAN and recorded in the United States Patent and Trademark Office at Reel 012584, Frame 0124, the real party in interest is as follows:

Samsung SDI Co., Ltd.
575 Sin-dong, Paldal-ku,
Suwon-city, Kyungki-do
Republic of Korea

II. Related Appeals and Interferences

Although the real party in interest has other appeals and interferences, none of the other pending appeals and interferences is believed to directly affect or be directly affected by, or have any bearing upon the decision of the Board of Patent Appeals and Interferences in this appeal.

III. Status of Claims

The status of the claims of the application is as follows:

Claims 1 – 9, 17, 38 and 39: rejected.

Claims 10 – 16 and 18 – 28: canceled.

Claims 29 – 37: withdrawn from consideration.

Claims 1 – 9, 17, and 38 – 39 are the subject of this appeal.

IV. Status of Amendments

Claims 1 – 17 and 38 – 39 were rejected in the Office Action mailed February 6, 2006.

An amendment to claim 10, presented in Applicants' response dated May 5, 2006, was not entered, according to an Advisory Action mailed May 16, 2006.

A subsequent amendment canceling claims 10 – 16, presented in Applicants' response dated June 5, 2006, was entered, according to an Advisory Action mailed June 20, 2006. The Advisory Action stated that the rejection of claims 10 – 16 was withdrawn in view of the

cancellation of these claims. Accordingly, there are currently no outstanding issues regarding the status of amendments.

A copy of the claims involved in the appeal is included in the Claims Appendix.

V. Summary of the claimed subject matter

Aspects of the present invention are directed to a lithium-sulfur battery. In particular, the lithium-sulfur battery according to claim 1 comprises a positive electrode 3 having an electron-conductive path and an ion-conductive path (page 5, lines 28 – 30; paragraph [0022]) and comprising: a positive active material including an active sulfur, and pores of an average size greater than or equal to substantially 5 μm and less than and including 15 μm having both electron-conductive and ion-conductive properties, where the active sulfur is disposed in the pores during an electrochemical reaction of the lithium-sulfur battery (page 5, lines 30 - 31; paragraph [0022]). The positive electrode comprising the positive active material including an active sulfur is described generally throughout pages 5 – 10 of the specification. The limitation of pores of an average size greater than or equal to substantially 5 μm and less than and including 15 μm is described in the specification by the disclosure of sulfur particle sizes of 5 μm in Examples 1 - 5 and a sulfur particle size of 15 μm in Comparative Example 2 (amended in the Amendment filed on January 23, 2006 as “Example 6”), together with the description at page 10, lines 24 – 26 (paragraph [0041] that the pore size of the positive electrode 3 corresponds to the size of the sulfur particle present in the positive electrode immediately prior to injecting the electrolyte or polysulfide solution.

The lithium battery further according to claim 1 further comprises a negative electrode comprising a negative active material selected from the group consisting of a lithium metal, a lithium-containing alloy, materials which can reversibly intercalate/deintercalate lithium ions, or

materials which can reversibly form a chemical compound with lithium; as described, for example, at page 4, line 18 - 20 (paragraph [0017]) and page 10, lines 27 – 29 (paragraph [0042]).

The lithium battery according to claim 1 further comprises a separator interposed between the positive and negative electrodes 10 – 12, as described, for example, at page 4, line 20 – 21 (paragraph [0017]) and page 11, lines 10 – 12.

The lithium battery according to claim 1 further comprises an ion-conductive electrolyte as described, for example, at page 4, line 21 (paragraph [0017]) and page 11, lines 13 to page 12, line 2.

The lithium battery of claim 4 is the lithium battery of claim 1 wherein said positive electrode is prepared by a method comprising mixing an elemental sulfur (S_8) powder, a conductive agent, and a binder to provide a positive active material slurry; and coating the positive active material slurry on a current collector, as described, for example, at page 7, lines 1 – 11 (paragraphs [0025] and [0026]). As described therein, the pores of the positive electrode are formed as the elemental sulfur is reduced to polysulfide during the electrochemical redox reaction of the battery.

The lithium battery of claims 5 – 7 is the lithium battery of claim 1, wherein an average particle size of the elemental sulfur is greater than 0 μm and up to 20 μm (claim 5) or greater than 0 μm and up to 10 μm (claim 6) or greater than 0 μm and up to 5 μm (claim 7), as described at page 7, lines 9 – 11 (paragraph [0026]).

The lithium battery of claim 9 is the lithium battery of claim 4 wherein after preparing said positive electrode, a polysulfide solution is added to the lithium-sulfur battery, as described at page 8, line 16 – 18 (paragraph [0033]).

VI. Grounds of rejection

The following is a concise statement of each ground of appeal.

1. Whether claims 1 - 4, 8 - 9, 17, 38, and 39 are patentable under 35 U.S.C. §103 over Chu (U.S. Patent No. 5,523,179) in view of Japanese patent publication no. 47-28431; and
2. Whether claims 5-7 are patentable under 35 U.S.C. §103 over Chu (U.S. Patent No. 5,523,179) in view of Japanese patent publication no. 47-28431 and Kovalev et al. (U.S. Patent No. 6,652,440).

VII. Arguments

1. **Claims 1 - 4, 8 - 9, 17, 38, and 39 are patentably distinguishable over Chu (U.S. Patent No. 5,523,179) (hereinafter, "Chu") and Japanese patent publication no. 47-28431 (Abstract) (hereinafter, "JP '431").**

As a general matter, in order to establish a prima facie obviousness rejection, the Examiner needs to provide both the existence of individual elements corresponding to the recited limitations, and a motivation to combine the individual elements in order to create the recited invention. The Examiner is further required to evaluate the record as a whole, and to account for contrary teachings existing in the record. In re Young, 927 F.2d 588, 18 USPQ2d 1089, (Fed. Cir. 1991) cited by MPEP 2143.01. Should the Examiner fail to provide evidence that either one of the individual elements or the motivation does not exist in the prior art, then the Examiner has not provided sufficient evidence to maintain a prima facie obviousness rejection of the claim. In re Kotzab, 217 F.3d 1365, 55 USPQ2d 1313 (Fed. Cir. 2000). Thus, the burden is initially on the Examiner to provide particular evidence as to why one of ordinary skill in the art would have been motivated to combine the individual elements to create the recited invention, and to demonstrate that this evidence existed in the prior art. In re Zurko, 258 F.3d 1379, 59 USPQ2d 1693 (Fed. Cir. 2001).

A. The combination of Chu and JP '431 does not teach all of the express limitations of independent claim 1 - 3, 17, 38, and 39.

As review, independent claim 1 relates to a lithium-sulfur battery comprising a positive electrode having an electron-conductive path and an ion-conductive path and comprising: a positive active material including an active sulfur, and pores of an average size greater than or equal to substantially 5 μm and less than and including 15 μm having both electron-conductive and ion-conductive properties, where the active sulfur is disposed in the pores during an electrochemical reaction of the lithium-sulfur battery; a negative electrode comprising a negative active material selected from the group consisting of a lithium metal, a lithium-containing alloy, materials which can reversibly intercalate/deintercalate lithium ions, or materials which can reversibly form a chemical compound with lithium; a separator interposed between said positive and negative electrodes; and an ion-conductive electrolyte.

The combination of Chu and JP '431 does not teach or suggest all of the express limitations of independent claim 1. In particular, claim 1 of the present application reads in part "...a positive electrode having an electron-conductive path and an ion-conductive path and comprising: a positive active material including an active sulfur, and pores of an average size greater than or equal to substantially 5 μm and less than and including 15 μm having both electron-conductive and ion-conductive properties, where the active sulfur is disposed in the pores during an electrochemical reaction of the lithium-sulfur battery..." [emphasis added]. On the other hand, JP '431, which the Examiner relies upon for allegedly teaching the claimed pore sizes, describes a porous conductor consisting of a graphite felt or cloth having pore diameters ranging from 10 μm to 1000 μm . JP '431 contains no teaching or suggestion as to what the average pore size is of the graphite felt or cloth. Clearly, an average pore size can not be assumed from a disclosure of a range of pore sizes in a material and JP '431 contains no teaching or suggestion that an average pore size of its material would lie within the claimed

range. The allegation made by the Examiner that in JP '431, one of the two end points, 10 μm , constitutes a valid data point and fully encompasses the claim as a specific disclosure of a discrete embodiment of the invention, is therefore without basis, since JP '431 does not disclose any material having an average pore size of 10 μm . Thus, JP '431 does not overcome the failure of Chu to teach the average pore size of independent claim 1, and the combination of Chu and JP '431 therefore does not teach or suggest all of the features of independent claim 1.

B. The combination of Chu and JP '431 does not teach all of the express limitations of dependent claims 4 and 8.

As a separate argument for the patentability of claims 4 and 8, these claims relate to a lithium-sulfur battery wherein the positive electrode is prepared by a method comprising mixing an elemental sulfur (S_8) powder, a conductive agent, and a binder to provide a positive active material slurry; and coating the positive active material slurry on a current collector. The product that is obtained by these operations is clearly different and distinguishable from any product that would be made according to the disclosures of Chu and JP '431, singly or combined. In particular, claim 4 depends from claim 1 and therefore is a method of forming a positive active material including an active sulfur, and pores of an average size greater than or equal to substantially 5 μm and less than and including 15 μm . Chu, while describing the mixture of elemental, active sulfur, electronically conductive material and an ionically conductive material intermixed with the active sulfur does not describe mixing an elemental sulfur powder. Consequently, Chu does not describe any method of creating an active material having pores or any method that would inherently form a material having pores, specifically pores of the size required by claim 1. JP '431 does not supply the missing elements from the disclosure of Chu, since JP '431 does not describe any method comprising mixing an elemental sulfur (S_8) powder, a conductive agent, and a binder to provide a positive active material slurry; and coating the positive active material slurry on a current collector. JP '431 describes forming a porous

conductor by combining a graphite felt or cloth with melted sulfur. Clearly, the positive electrode obtained by combining a graphite felt or cloth with melted sulfur, or by incorporating a graphite felt or cloth into an active material would be different, chemically and morphologically, from a positive electrode that is prepared by a method comprising mixing an elemental sulfur (S₈) powder, a conductive agent, and a binder to provide a positive active material slurry and coating the positive active material slurry on a current collector. Therefore, the combination of Chu and JP '431 does not teach or suggest a lithium-sulfur battery wherein the positive electrode is prepared by a method comprising the operations described in claim 4. Claim 8 depends from claim 4 and is patentable over Chu and JP '431 for the same reasons given for claim 4. Therefore, the rejection of claims 4 and 8 should be reversed for these additional reasons.

C. The combination of Chu and JP '431 does not teach all of the express limitations of dependent claim 9.

As a separate argument for the patentability of claim 9, this claim relates to a lithium-sulfur battery wherein the positive electrode is prepared by the method of claim 4 and further comprising adding a polysulfide solution to the lithium-sulfur battery after preparing the positive electrode. In the Office Action of February 6, 2006, the Examiner noted that Chu at col. 4, lines 30 – 36 and col. 4, lines 60 – 65 mentions the presence of a polysulfide material. However, these passages of Chu clearly refer to polysulfides that form *in situ* upon discharge of the battery. Chu does not teach or suggest any operation of adding a polysulfide solution to a lithium-sulfur battery after preparing the positive electrode. JP '431 contains no mention of polysulfides at all. Therefore, Chu and JP '431 do not teach or suggest all the limitations of claim 9, and the rejection of claim 9 should be reversed for this additional reason.

D. There is insufficient evidence of record of a motivation to combine Chu and JP '431 in a manner meeting the invention as recited in claims 1 - 4, 8 - 9, 17, 38, and 39.

As review, independent claim 1 relates to a lithium-sulfur battery comprising a positive electrode having an electron-conductive path and an ion-conductive path and comprising: a

positive active material including an active sulfur, and pores of an average size greater than or equal to substantially 5 μm and less than and including 15 μm having both electron-conductive and ion-conductive properties, where the active sulfur is disposed in the pores during an electrochemical reaction of the lithium-sulfur battery; a negative electrode comprising a negative active material selected from the group consisting of a lithium metal, a lithium-containing alloy, materials which can reversibly intercalate/deintercalate lithium ions, or materials which can reversibly form a chemical compound with lithium; a separator interposed between said positive and negative electrodes; and an ion-conductive electrolyte.

The positive electrode described in Chu is made from an electrode composition comprising active-sulfur, an electronically conductive material and an ionically conductive material intermixed with the active sulfur (see, for example, Col. 5, lines 1 – 8 of Chu). Chu not only does not mention specific pore sizes of its material, but also does not even mention whether its material has pores at all.

JP '431 describes a battery that comprises a cathode activator of melted sulfur and a solid electrolyte. The reference states that it is necessary to use a porous conductor consisting of graphite cloth or felt to increase the conductivity of the sulfur.

In the final Office Action of February 6, 2006, the Examiner alleged that JP '431 discloses that it is essential to use a porous conductor consisting of a material having a degree of porosity with pore diameters of 10 – 1000 μm as a cathode member to increase the conductivity of the cathode. The Examiner took the position that it would have been obvious to make Chu's positive active material including sulfur by having the specific pore size of the JP '431 on the alleged grounds that the JP '431 reveals that in a battery system using sulfur it is essential to use a porous conductor consisting of a material having a degree of porosity with pore diameters of 10 – 1000 μm as a cathode member to increase the conductivity of the

cathode. In other words, the Examiner apparently interprets JP '431 as teaching that a porous conductor consisting of a material having a degree of porosity with pore diameters of 10 – 1000 μm as a cathode member would increase the conductivity of any cathode containing sulfur as an active material, no matter what the structure or composition of the cathode.

It is respectfully submitted that a person skilled in the art, considering the teachings of Chu as a whole and considering the teachings of JP '431 as a whole would not have found any motivation to combine the references. Particularly, there would have been no motivation for incorporating a porous material or a specific pore size described in JP '431 into the material of Chu. In the positive electrode of Chu, conductivity is provided by the fact that the active sulfur is thoroughly mixed with an electronically conductive material and an ionically conductive material (see, for example, col. 5, lines 1 – 8 of Chu.) JP '431, on the other hand, is specifically directed to the problem of providing conductivity to a melted sulfur cathode, in view of the poor conductivity of sulfur. A person skilled in the art considering the positive electrode of Chu would not have been faced with the same problem described in JP '431 of providing conductivity to a mass of melted sulfur because the active sulfur in Chu is thoroughly mixed with an electronically conductive material and an ionically conductive material. There is nothing in JP '431 that teaches or suggests that the addition of pores to the uniform dispersal of Chu, wherein the active sulfur is thoroughly mixed with an electronically conductive material and an ionically conductive material, would have any beneficial effect on its conductivity. Therefore, the Examiner's alleged motivation to combine Chu and JP '431 in order to achieve an increase in conductivity is without basis.

In paragraph 5 (page 4) of the Advisory Action dated June 20, 2006, the Examiner's response to Applicants' previously asserted arguments regarding lack of motivation to combine the teachings of Chu and JP '431 was to state that "the fact that applicant has recognized another advantage which would flow naturally from following the suggestion of the prior art

cannot be the basis for patentability when the differences would otherwise be obvious." The Examiner cited Ex parte Obiaya, 227 U.S.P.Q. 58, 60, (Bd. Pat. App. & Inter. 1985). Similarly, at paragraphs 10 – 11 (pages 7 – 9) of the Advisory Action, the Examiner repeated the argument that the fact that the applicant has recognized another advantage/disadvantage which would flow naturally from the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. The Examiner further cites In re Keller, 642 F.2d 413, 208 U.S.P.Q. 871 (CCPA 1981) as supporting the statement that "[i]n addition to that, the test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference; nor is it that the claimed invention must be expressly suggested in any one or all of the references. Rather, the test is what the combined teachings of the reference would have suggested to those of ordinary skill in the art." These arguments by the Examiner do not address the central issue of motivation. In particular, the fact that Chu presents a different solution to the issue of conductivity, by thoroughly mixing active sulfur with an electronically conductive material and an ionically conductive material, directly relates to the question of whether a person skilled in the art, considering the teachings of Chu as a whole, would have had any motivation to consider a reference directed to solving the problem of conductivity in a melted sulfur cathode. Since conductivity is not an unsolved problem in Chu, there would be no such motivation. Therefore, the Examiner has not met the burden of establishing a *prima facie* case of obviousness of claims 1 – 4, 8 – 9, 17, 38, and 39 over Chu and JP '431. Further, contrary to what is alleged by the Examiner in paragraph 11 of the Advisory Action dated June 20, 2006, since the Examiner has not established a *prima facie* case of obviousness, the burden has not shifted to the applicant to prove non-obviousness.

For all of the above reasons, the rejection of claims 1 – 4, 8-9, 17, 38, and 39 over Chu and JP '431 should be reversed.

2. Claims 5 – 7 are patentable under 35 U.S.C. §103 over Chu (U.S. Patent No. 5,523,179) in view of Japanese patent publication no. 47-28431 and Kovalev et al. (U.S. Patent No. 6,652,440).

The combination of Chu, JP '431 and Kovalev et al. does not teach all of the express limitations of dependent claim 9.

As review, claims 5 – 7 depend from claim 4 and relate to the average particle size of the elemental sulfur that is mixed with a conductive agent, and a binder to provide a positive active material slurry; and coated the positive active material slurry on a current collector in the formation of a positive electrode.

In the final Office Action dated February 6, 2006, the Examiner alleged that Kovalev et al. teaches electroactive cathode materials for electrochemical cells wherein the cathode materials comprise sulfur-sulfur bonds such as elemental sulfur and that the cathode materials are useful in batteries employing alkali-metal anodes, in particular, lithium or lithium alloy anodes and that in one embodiment, the particle size of the elemental sulfur is from 0.01 to 100 microns. The Examiner took the position that it would have been obvious to one skilled in the art at the time the invention was made to use the specific particle size of the elemental sulfur of Kovalev et al. in the lithium-sulfur battery of Chu and JP '431 on the alleged grounds that Kovalev et al. teaches that elemental sulfur having the claimed particle size is useful for making positive electrodes of lithium-sulfur batteries because this particular positive electrode material exhibits satisfactory specific capacity in combination with a lithium anode.

The differences between claim 4, from which claims 5 – 7 depend, and the disclosures of Chu and JP '431 are discussed above.

In Kovalev et al., it is described that a dispersion of elemental sulfur having a particle size of 0.01 microns to 100 microns in a liquid medium containing a non-conductive polymer is combined with a precursor of a conductive polymer repeating unit and a polymerization initiator

comprising an oxidant and the mixture is reacted to form a grafted organic polymer. See, for example, col. 5, lines 6 – 20 and col. 12, lines 8 – 9 of Kovalev et al. In other words, the elemental sulfur having the particle size noted by the Examiner is a starting material used in a reaction forming an electroactive, grafted organic polymer. The resulting polymer, as described, for example, at col. 7, lines 19 – 22 of Kovalev et al. is a polymer comprising conductive polymer segments and non-conductive polymer segments, wherein one or more of the conductive and non-conductive polymer segments are bonded to sulfide chains, particularly sulfide chains comprising one or more moieties selected from the group consisting of $-(S_m)-$, $-(S_m)^-$, and $(S_m)^{2-}$ where m is an integer from 3 to 200. It is this electroactive polymer having polysulfide chains that is used in the cathode described in Kovalev et al. Accordingly, there is no description in Kovalev et al., singly or combined with Chu and JP '431, of a lithium-sulfur battery wherein the positive electrode is prepared by a method comprising mixing an elemental sulfur (S_8) powder having the particle sizes defined in claims 5 - 7, a conductive agent, and a binder to provide a positive active material slurry; and coating the positive active material slurry on a current collector.

Therefore, Kovalev et al., Chu and JP '431, singly or combined, do not teach or suggest all of the features of claims 5 - 7, and the rejection of claims 5 – 7 over Chu, JP '431, and Kovalev et al. should be reversed.

VIII. Conclusion

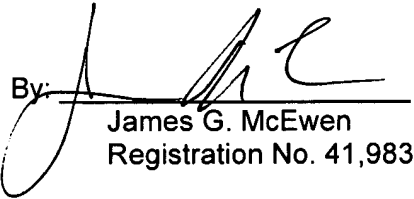
In view of the law and facts stated herein, the Appellant respectfully submits that the Examiner has failed to cite a reference or combination of references sufficient to maintain obviousness rejections of the rejected claims and has failed to rebut the arguments in the Amendment dated June 5, 2006 and in the applicants' previous responses.

For all the foregoing reasons, the Appellant respectfully submits that the cited prior art does not teach or suggest the presently claimed invention. The claims are patentable over the prior art of record and the Examiner's findings of unpatentability regarding claims 1 – 9, 17, and 38 – 39 should be reversed.

The Commissioner is hereby authorized to charge any additional fees required in connection with the filing of the Appeal Brief to our Deposit Account No. 50-3333.

Respectfully submitted,

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IX. Claims Appendix

1. A lithium-sulfur battery comprising:

a positive electrode having an electron-conductive path and an ion-conductive path and comprising: a positive active material including an active sulfur, and pores of an average size greater than or equal to substantially 5 μm and less than and including 15 μm having both electron-conductive and ion-conductive properties, where the active sulfur is disposed in the pores during an electrochemical reaction of the lithium-sulfur battery;

a negative electrode comprising a negative active material selected from the group consisting of a lithium metal, a lithium-containing alloy, materials which can reversibly intercalate/deintercalate lithium ions, or materials which can reversibly form a chemical compound with lithium;

a separator interposed between said positive and negative electrodes; and
an ion-conductive electrolyte.

2. The lithium-sulfur battery according to claim 1, wherein the average size of the pores is up to 10 μm .

3. The lithium-sulfur battery according to claim 1, wherein the average size of the pores is substantially 5 μm .

4. The lithium-sulfur battery according to claim 1, wherein said positive electrode is prepared by a method comprising:

mixing an elemental sulfur (S_8) powder, a conductive agent, and a binder to provide a positive active material slurry; and

coating the positive active material slurry on a current collector.

5. The lithium-sulfur battery according to claim 4, wherein an average particle size of the elemental sulfur is greater than 0 μm and is up to 20 μm .

6. The lithium-sulfur battery according to claim 4, wherein an average particle size of the elemental sulfur is greater than 0 μm and is up to 10 μm .

7. The lithium-sulfur battery according to claim 4, wherein an average particle size of the elemental sulfur is greater than 0 μm and is up to 5 μm .

8. The lithium-sulfur battery according to claim 4, wherein the mixing step is performed with a ball mill.

9. The lithium-sulfur battery according to claim 4, wherein, after preparing said positive electrode, a polysulfide solution is added to the lithium-sulfur battery.

17. The lithium-sulfur battery according to claim 1, wherein the ion-conductive properties are supplied using an ionic conductive medium selected from the group consisting of ethylene carbonate, propylene carbonate, dioxolane, sulfolane, xylene, diglyme, tetrahydrofuran, tetraglyme, sulfone, dimethyl sulfone, dialkyl carbonate, butyrolactone, N-methyl pyrrolidone, tetramethyl urea, glyme, crown ether, dimethoxy ethane, N,N-diethyl formamide, N,N-diethyl acetamide, hexamethyl phosphoamide, pyridine, dimethyl sulfoxide, N,N-dimethyl acetamide, tributyl phosphate, trimethyl phosphate, N,N,N,N-tetraethyl sulfamide, tetramethylene

diamine, tetramethyl propylene diamine, pentamethylene triamine, methanol, ethylene glycol, polyethylene glycol, nitromethane, trifluoro acetic acid, trifluoro methane sulfonic acid, sulfur dioxide, and boron trifluoride, and a mixture thereof.

38. The lithium-sulfur battery of claim 1, wherein said electrolyte is a solid.

39. The lithium sulfur battery of claim 38, wherein said solid electrolyte comprises one of a glass electrolyte, a polymer electrolyte, a ceramic electrolyte, and a mixture of polymer electrolyte with a supporting electrolyte salt.

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X. Evidence Appendix

NONE

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XI. Related Proceedings Appendix

NONE